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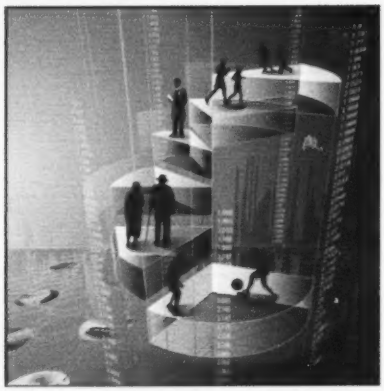

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...	not applicable
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0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Mortality from diabetes mellitus, 2004 to 2008: A multiple-cause-of-death analysis

by Jungwee Park and Paul A. Peters

Abstract

Using multiple-cause-of-death data, this study examines diabetes mellitus as a cause of mortality. During the 2004-to-2008 period, diabetes mellitus was listed as either the underlying cause or a contributing cause of 119,617 deaths. It was more than twice as likely to be a contributing than the underlying cause of death. And when it was identified as the underlying cause of death, diabetes mellitus was rarely the only cause. The diabetes mellitus mortality rate was relatively high among males, older individuals, and people living in lower-income neighbourhoods. Provincial/Territorial differences in rates of death from diabetes mellitus were considerable. When diabetes mellitus was the underlying cause of death, cardiovascular diseases were listed as a contributing cause most often, and when diabetes mellitus was a contributing cause, cardiovascular diseases were most likely to be the underlying cause.

Keywords

Cardiovascular diseases, comorbidity, data linkage, death certificates, socio-economic factors, vital statistics

Authors

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Diabetes mellitus is one of the most common chronic diseases in Canada. It occurs when the body is either unable to sufficiently produce or properly use insulin. Insulin, a hormone secreted by beta cells in the pancreas, enables the cells of the body to absorb sugar from the bloodstream and use it as an energy source.[1] People with type 1 diabetes mellitus produce little or no insulin; in type 2 diabetes mellitus, the pancreas continues to make insulin, but the body develops resistance to its effects or an insulin deficiency.

In 2008/2009, close to 2.4 million Canadians, about 7% of the population, were living with diagnosed diabetes.[1] Although many of its complications are associated with mortality, diabetes mellitus itself is not usually reported as the primary cause of death.[1] For example, it is a risk factor for vascular complications such as coronary heart disease, peripheral vascular disease, kidney disease and nerve damage,[2] which are often listed as the underlying cause on the death certificate rather than diabetes mellitus.

In accordance with international conventions, a single underlying cause is identified as the disease or injury that initiated the train of events leading directly to death.[3] But for conditions that are often accompanied by a number of comorbidities, there may be no direct etiologic chain to facilitate identification of a single underlying cause[4,5]; instead, a combination of multiple factors results in mortality. Thus, the choice of an underlying cause may obscure the contribution of chronic conditions like diabetes mellitus. To overcome this limitation, multiple cause-of-death statistics that include contributing causes as well as the underlying cause are used. Such data provide a better understanding of how chronic conditions are associated with mortality.

Recently, Statistics Canada created a dataset that electronically captures underlying and contributing causes recorded on death certificates (see *The data*). These contributing causes may include conditions recorded as the immediate cause of death, diseases intervening between the underlying and immediate cause, and contributory conditions outside the sequence of conditions leading to death. Based on these new data, this analysis presents a more complete picture of diabetes mellitus as a cause of death from 2004 through 2008.

More likely to be contributing cause

In those five years, a total of 120,050 diabetes-mellitus-related deaths were recorded in Canada (Table 1). They accounted for 10.6% of all deaths that occurred in the period. Diabetes mellitus was the underlying cause of 37,041 of these deaths and a contributing cause for the remaining 83,009. Thus, the disease was more than twice as likely to be coded as a contributing cause rather than as the underlying cause of death.

Crude mortality rates for diabetes mellitus as the underlying cause were stable over the five years at around 24 deaths per 100,000 males and 21 deaths per 100,000 females (Chart 1). However, rates for diabetes mellitus as a contributing cause rose from 50 to 57 deaths per 100,000 males and from 44 to 50 deaths per 100,000 females, an increase of about 15%, compared with a 7% increase in crude mortality rates for causes not related to diabetes (data not shown).

The upturn in diabetes mellitus as a contributing cause of death may be associated with the increasing prevalence of the disease. Results from the Canadian Community Health Survey show that from 2003 to 2007/2008, the prevalence of diabetes mellitus rose from 4.6% to 5.8% of the population aged 12 or older (from 1.22 to 1.67 million) (data not shown). The growing number of people with the disease may have resulted in more deaths from complications rather than from diabetes mellitus as the underlying cause.[1]

Table 1
Number of deaths and crude mortality rate per 100,000 population for diabetes mellitus as underlying and contributing cause, by sex, age group, neighbourhood income quintile and province/territory, Canada, 2004 to 2008

	Underlying cause[†]		Contributing cause		Ratio	Total	
	Number of deaths	Crude rate	Number of deaths	Crude rate	(contributing to underlying)	Number of deaths	Crude rate
Both sexes	**37,041**	**22.7**	**83,009**	**50.9**	**2.24**	**120,050**	**73.6**
Male	19,201	23.8	44,214	54.7	2.30	63,415	78.5
Female	17,840	21.7	38,795	47.2	2.17	56,635	68.9
Age group (years)[‡]							
Younger than 45	757	0.8	841	0.9	1.11	1,598	1.6
45 to 64	5,672	13.0	11,477	26.3	2.02	17,149	39.3
65 to 74	7,311	63.7	17,869	155.8	2.44	25,180	219.6
75 to 84	12,994	171.2	30,964	408.0	2.38	43,958	579.1
85 or older	10,307	394.1	21,857	835.8	2.12	32,164	1229.9
Neighbourhood income quintile[§]							
Lowest	9,973	31.4	21,283	67.1	2.13	31,256	98.5
Second	8,109	25.7	18,472	58.5	2.28	26,581	84.2
Third	6,861	21.8	15,937	50.5	2.32	22,798	72.3
Fourth	6,458	20.4	14,439	45.7	2.24	20,897	66.2
Highest	5,346	17.2	12,209	39.2	2.28	17,555	56.4
Province/Territory						119,087	
Newfoundland	1,139	44.6	2,248	88.0	1.97	3,387	132.6
Prince Edward Island	134	19.4	308	44.6	2.30	442	63.9
Nova Scotia	1,259	26.9	3,377	72.0	2.68	4,636	98.9
New Brunswick	1,162	31.1	2,006	53.7	1.73	3,168	84.8
Quebec	7,769	20.3	16,187	42.4	2.08	23,956	62.7
Ontario	14,757	23.3	34,378	54.3	2.33	49,135	77.6
Manitoba	2,053	34.6	3,016	50.8	1.47	5,069	85.4
Saskatchewan	1,550	31.0	2,912	58.3	1.88	4,462	89.3
Alberta	2,153	12.6	8,232	48.2	3.82	10,385	60.8
British Columbia	5,035	23.7	10,271	48.2	2.04	15,306	71.9
Yukon	18	11.2	37	22.9	2.06	55	34.1
Northwest Territories	11	5.1	33	15.2	3.00	44	20.3
Nunavut	x	x	x	x	x	x	x

† when a diabetes mellitis condition is reported as the underlying cause and other diabetes mellitis condition(s) is(are) listed as a contributing cause for the same death, diabetes mellitus is considered to be underlying cause
‡ one case missing
§ 243 cases missing
x suppressed to meet confidentiality requirements of Statistics Act
Source: Vital Statistics, Multiple Cause of Death File, 2004 to 2008.

Higher among males

Diabetes mellitus was more likely to be cause of death among males than among females. Over the 2004-to-2008 period, the crude mortality rate for diabetes mellitus as the underlying cause was 23.8 deaths per 100,000 males and 21.7 deaths per 100,000 females. As a contributing cause, the crude rates were were 54.7 deaths per 100,000 males and 47.2 deaths per 100,000 females.

Rates rise with age

Regardless of whether diabetes mellitus was coded as a contributing cause or the underlying cause, the average age at death was around 76 (74 or 75 for men; 79 for women) (Table 2).

The crude mortality rate for diabetes mellitus as the underlying cause rose from 0.8 deaths per 100,000 people younger than 45 to 394.1 deaths per 100,000 people aged 85 or older. As a contributing cause, the crude mortality rate rose from 0.9 deaths per 100,000 people younger than 45 to 835.8 deaths per 100,000 people aged 85 or older. The percentage of deaths that were related to diabetes increased from less than 3% among people younger than 45 to 13% at ages 65 to 84, and then fell to 9% of deaths at age 85 or older (data not shown).

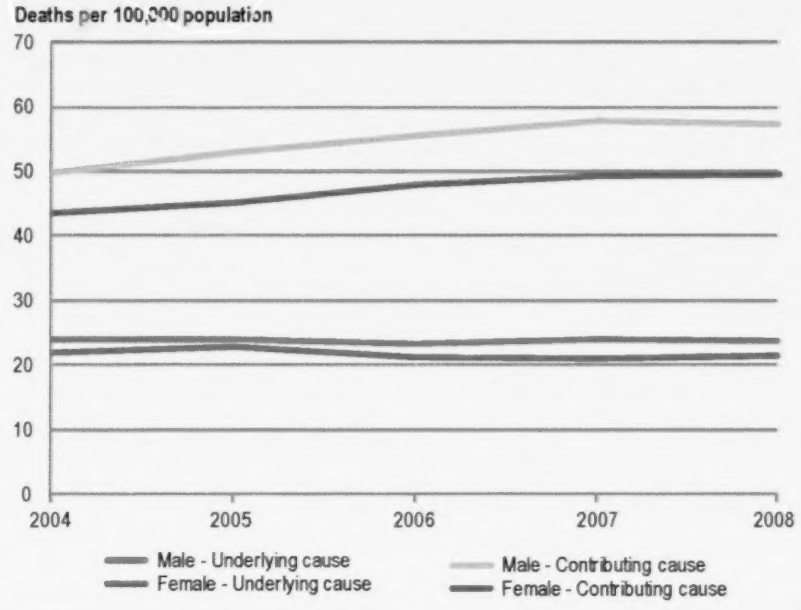
Higher income/Lower rates

Crude mortality rates for diabetes mellitus varied by neighbourhood income.[7] The highest rates were in the lowest income quintile neighbourhoods (31.4 deaths per 100,000 population when diabetes was the underlying cause; 67.1 deaths per 100,000 when it was a contributing cause); the lowest rates were in the highest income quintile neighbourhoods (17.2 and 39.2, respectively).

Geographic differences

Differences in provincial/territorial crude mortality rates for diabetes mellitus were substantial. For instance, the rate in Newfoundland was 45 deaths per 100,000 population, compared with 13 deaths per 100,000 population in Alberta. Rates tended to be relatively low in

Figure 1
Crude mortality rate per 100,000 population for diabetes mellitus as underlying and contributing cause, by sex, Canada, 2004 to 2008



Source: Vital Statistics, Multiple Cause of Death File, 2004 to 2008

Table 2
Selected characteristics of deaths with diabetes mellitus as underlying and contributing cause, by sex, Canada, 2004 to 2008

	Underlying cause			Contributing cause		
	Both sexes	Males	Females	Both sexes	Males	Females
Average age at death (years)	76.2	73.7	78.9	76.7	74.8	78.9
Number of other causes (%)						
0	1.4	1.5	1.2	0.0	0.0	0.0
1	10.1	10.2	10.1	6.2	6.3	6.0
2	24.5	24.4	24.6	19.9	19.8	19.9
3	27.3	27.1	27.6	24.8	24.7	24.9
4	18.6	18.5	18.7	19.8	20.0	19.6
5	10.1	10.2	10.0	13.0	13.0	13.1
6	4.4	4.4	4.3	7.7	7.6	7.8
7+	3.6	3.6	3.6	8.7	8.6	8.7
Average number of other causes	3.2	3.2	3.2	3.8	3.8	3.8
As % of all deaths	3.3	3.4	3.2	7.3	7.7	6.9

Source: Vital Statistics, Multiple Cause of Death File, 2004 to 2008

The data

This analysis is based on the Multiple Cause of Death file. All causes entered on a death certificate are routinely coded, and those codes yield raw multiple-cause data.[5] To produce multiple-cause-of-death data, computing software (Automated Classification of Medical Entities—ACME) assigned the underlying cause based on the World Health Organization rules for selection and modification and the causal relationships among diseases. Another system (TRANSAX) converted death codes to a form amenable to person-based analysis of multiple causes. This software eliminates redundant causes within death certificates and, where appropriate, combines pairs of codes into a third code.[5]

Multiple-cause-of-death data were obtained from all provinces and territories from 2000 to 2008—a total of 1,811,406 records. Because the data for some provinces and territories were incomplete for earlier years, this analysis was limited to the 2004-to-2008 period.

To produce data at the national level, the multiple-cause information was merged with the Canadian Vital Statistics Death database maintained by Statistics Canada. The merge was based on the death registration number, province, and year of occurrence. Because of mismatches between the two datasets, 3.3% of all deaths (2.5% of diabetes-mellitus-related deaths) were excluded from the analysis.

Prince Edward Island, Quebec, Alberta, British Columbia, Yukon and Northwest Territories. This geographic distribution of mortality reflects the provincial/territorial prevalence of diagnosed diabetes mellitus.[1]

Rarely single cause

Diabetes mellitus was rarely the single cause of death. It was the only cause for just 1.4% of the deaths reported over the 2004-to-2008 period. By contrast, the percentage of all deaths with a single cause during this period was 16%.

When diabetes mellitus was identified as the underlying cause, an average of 3.2 other causes were recorded on the death certificate. For deaths overall, the average number of contributing causes was 2.2.

When diabetes mellitus was a contributing cause, on average, 5 conditions were listed on the death certificate (an underlying cause and 3 other contributing causes). The average number of causes on death certificates overall was about 3.

Co-existing causes

Whether diabetes mellitus was the underlying cause or a contributing cause, cardiovascular diseases were the most common co-existing conditions listed on death certificates. Nine out of ten deaths with diabetes mellitus identified as the underlying cause, also had cardiovascular diseases as a contributing cause (Table 3). Among these cardiovascular diseases, ischemic heart disease was reported most often (55%), followed by other cardiovascular diseases (52%), hypertensive heart disease (31%), and cerebrovascular disease (22%) (data not shown). Other contributing causes frequently reported for deaths from diabetes mellitus were genito-urinary diseases, neuropsychiatric conditions, respiratory diseases, endocrine disorders, respiratory infections, and digestive disorders.

When diabetes mellitus was a contributing cause, cardiovascular diseases were most often the underlying cause of death (45%). Diabetes mellitus was also commonly listed as a contributing cause in deaths from malignant neoplasms.

The close association between diabetes mellitus and specific diseases may reflect common risk factors. Diabetes mellitus and cardiovascular diseases share risk factors such as obesity, physical inactivity and poor nutrition. As well, the presence of diabetes mellitus is known to magnify the effects of other risk factors for diseases of the circulatory system, such as hypertension and smoking.[2]

Table 3
Number and percentage of deaths with diabetes mellitus as underlying and contributing cause, by other selected contributing and underlying causes, Canada, 2004 to 2008

	Both sexes		Male		Female	
	Number	%	Number	%	Number	%
Underlying cause - Diabetes mellitus	37,041	...	19,201	...	17,840	...
Contributing causes						
Cardiovascular diseases	32,984	89.0	17,218	89.7	15,766	88.4
Genitourinary diseases	14,172	38.3	7,370	38.4	6,802	38.1
Neuropsychiatric conditions	9,030	24.4	4,354	22.7	4,676	26.2
Respiratory diseases	8,002	21.6	4,290	22.3	3,712	20.8
Endocrine disorders	5,175	14.0	2,608	13.6	2,567	14.4
Respiratory infections	4,478	12.1	2,276	11.9	2,202	12.3
Digestive diseases	3,759	10.2	1,940	10.1	1,819	10.2
Contributing cause - Diabetes mellitus[†]	82,999	...	44,207	...	38,792	...
Underlying causes						
Cardiovascular diseases	36,978	44.6	20,024	45.3	16,954	43.7
Malignant neoplasms	18,204	21.9	10,524	23.8	7,680	19.8
Neuropsychiatric conditions	6,910	8.3	2,956	6.7	3,954	10.2
Respiratory diseases	5,579	6.7	3,090	7.0	2,489	6.4
Digestive diseases	3,602	4.3	1,814	4.1	1,788	4.6
Genitourinary diseases	2,613	3.2	1,295	2.9	1,318	3.4
Other diseases	9,113	11.0	4,504	10.2	4,609	11.9

† 10 cases missing because of insufficient information about ICD codes
... not applicable
Source: Vital Statistics, Multiple Cause of Death File, 2004 to 2008.

Conclusion

Cause-of-death data are typically based on the underlying cause, not on other causes that contributed to the death. However, single-cause mortality statistics may obscure the contribution of chronic conditions like diabetes mellitus, which is rarely an underlying cause of death.

Based on the multiple-cause death file, this study found that from 2004 to 2008, diabetes mellitus was more than twice as likely to be coded as a contributing cause rather than the underlying cause of death. Diabetes-mellitus-related mortality rates were higher among males, older individuals, and residents of lower-income neighbourhoods. When diabetes mellitus was included on a death certificate, cardiovascular diseases were listed most often as either the underlying or a contributing cause of death.

Future research on diabetes-mellitus-related deaths will be enhanced as multiple-cause-of-death data become available for longer periods. Also, analytical power can be increased by linking these data to sources that provide additional information about the deceased. ■

References

1. Public Health Agency of Canada. *Diabetes in Canada: Facts and Figures from a Public Health Perspective*. Ottawa: Public Health Agency of Canada, 2011.
2. Hodgson G, Mathur S. *Multiple causes of death: Diabetes as a case study*. Paper presented at the Tenth Biennial Conference of the Australian Population Association, Melbourne, Australia, November 28, 2000.
3. World Health Organization. *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Volume 1*. Geneva: World Health Organization, 1992.
4. Israel RA, Rosenberg HM, Curtin L. Analytical potential for multiple cause-of-death data. *American Journal of Epidemiology* 1986; 124(2): 161-79.
5. Deshpande SG. Value of statistics of multiple causes of death. *Regional Health Forum* 1997; 2(1): 55-8.
6. Wilkins K, Wysocki M, Morin C, Wood P. Multiple causes of death. *Health Reports* 1997; 9(2): 19-29.
7. Peters PA, Oliver LN, Carrière GM. Geozones: An area-based method for analysis of health outcomes. *Health Reports* 2012; 23(1): 1-11.